#15 Pet to w/D aba DW

Paul Kaskiewicz
P O Box 822
Princeton Jct. NJ 08550

ATTENTION: Petition Office
Commisioner of Patents and Trademarks
Washington DC 20231

24 October 2002

Subject: Petition to Withdraw Holding of Abandonment for Patent Application Number 09/673559

References:

1) Patent Application Number 09/673559.

2) Notice of Abandonment, PTO-1432 (Rev. 04-01), with mailing date 27 August 2002.

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Dear Sir or Madam,

1) Petition for Withdrawal of Holding of Abandonment

Regarding the Ref. 1 patent application, we are hereby petitioning for withdrawal of holding of abandonment per the Ref. 2 Notice of Abandonment (Attachment 1 hereto). Also, we are submitting a replacement response (Attachment 2 hereto), to replace our response to the Examiner that was lost within the USPTO.

We responded to the Examiner in time, as verified in Section 2 below. The documentary evidence and our telephone conversations with USPTO personnel reveal that our response to the Examiner was lost within the USPTO following its receipt there.

2) Evidence of Our In-Time Submittal of a Timely Response to the Examiner and Its Reception by the USPTO

We submit the following evidence of our having responded to the Examiner in time:

We mailed our response to the Examiner on 15 June 2002, as evidenced by the corresponding Certified Mail Receipt in Attachment 3(i) hereto.

The USPTO received our response to the Examiner on 24 June 2002, as evidenced by the corresponding USPS Domestic Return Receipt, Form 3811, in Attachment 3(ii) hereto.

Our response to the Examiner was accompanied by a check in the amount of $255 for an extension of time to respond to the Examiner. Said check was cashed by the USPTO on 2 July 2002.

On 1 July 2002, Ms. Karen Kolfer of the USPTO left me a voice message. I returned her call and spoke with her on 2 July 2002. Ms. Kolfer stated that whereas I had sent a check in the amount of $255, (a) only $200 was due, for a two month extension of time to respond, and (b) that the USPTO would refund $55, accordingly. Significantly, during our phone conversation Ms. Kolfer stated that she was holding in her hands our response to the Examiner (which she identified by its divider sheets and tabs). She also stated that the response would next be forwarded to Mr. Collins, the Examiner.

3) Summary

Based on the foregoing explanation and evidence, we request that the USPTO:

a) withdraw holding of abandonment for the Ref. 1 patent application, and

b) forward the replacement response to the Examiner, i.e. Enclosure 2, to the Examiner.

Sincerely yours,

Paul Kaskiewicz

Paul Kaskiewicz

Enclosures:

1) Notice of Abandonment, PTO-1432 (Rev. 04-01), with mailing date 27 August 2002. (3 pages)

2) Replacement for the lost response to the Examiner. (51 pages)

3(i) Certified Mail Receipt, dated 15 June 2002.

(ii) Domestic Return Receipt, stamped 'Received' by USPTO Receiving Center on 24 June 2002.

(1 page)

ENCLOSURE / ATTACHMENT 3(i)

SIERRA MADRE PO
SIERRA MADRE, California
910249998

06/15/2002 (626)836-3596 10:38:05 AM

Sales Receipt

Product Description	Sale Qty	Unit Price	Final Price
WASHINGTON DC 20231			$3.10
First-Class			
Return Receipt			$1.50
Certified			$2.10
Label Serial #: 70020510000430171652			
Issue PVI:			$6.70

Total: $6.70

Paid by:
Cash $10.00
Change Due: -$3.30

Bill#: 1000500910343
Clerk: 07

Refunds only per DMM P014
Thank you for your business
Customer Copy

7002 0510 0004 3017 1652

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CERTIFIED MAIL RECEIPT
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Postage	$ $3.10
Certified Fee	$2.10
Return Receipt Fee (Endorsement Required)	$1.50
Restricted Delivery Fee (Endorsement Required)	$0.00
Total Postage & Fees	$ $6.70

0860
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06/15/2002

Sent To MR. TIMOTHY D. COLLINS, USPTO EXAMINER
US DEPT OF COMMERCE, US PATENT & TRADEMARK OFFICE
Street, Apt. No.; or PO Box No. COMMISSIONER OF PATENTS & TRADEMARKS
City, State, ZIP+4 WASHINGTON DC 20231

PS Form 3800, January 2001 See Reverse for Instructions

ENCLOSURE / ATTACHMENT 3(ii)

SENDER: COMPLETE THIS SECTION

- Complete items 1, 2, and 3. Also complete item 4 if Restricted Delivery is desired.
- Print your name and address on the reverse so that we can return the card to you.
- Attach this card to the back of the mailpiece, or on the front if space permits.

1. Article Addressed to:

MR TIMOTHY D. COLLINS
USPTO EXAMINER
US DEPARTMENT OF COMMERCE
US PATENT AND TRADEMARK OFFICE
COMMISSIONER OF PATENTS AND TRADEMARKS
WASHINGTON D.C. 20231

COMPLETE THIS SECTION ON DELIVERY

A. Signature
X ☐ Agent ☐ Addressee

B. Received by (Printed Name) C. Date of Delivery

D. Is delivery address different from item 1? ☐ Yes
If YES, enter delivery address below: ☐ No

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3. Service Type
☐ Certified Mail ☐ Express Mail
☐ Registered ☐ Return Receipt for Merchandise
☐ Insured Mail ☐ C.O.D.

4. Restricted Delivery? (Extra Fee) ☐ Yes

2. Article Number (Transfer from service label) 7002 0510 0004 3017 1652

PS Form 3811, August 2001 Domestic Return Receipt 102595-02-M-1035

ENCLOSURE / ATTACHMENT 1

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/673,559	02/22/2001	Albert T. Wu	728.1.001	8585

7590 08/27/2002

TURBOSAT TECHNOLOGY, INC.
P.O. BOX 822
PRINCETON JUNCTION, NJ 08550

EXAMINER	
COLLINS, TIMOTHY D	

ART UNIT	PAPER NUMBER
3643	

DATE MAILED: 08/27/2002

Please find below and/or attached an Office communication concerning this application or proceeding.

Notice of Abandonment	Application No. 09/673,559	Applicant(s) WU ET AL.
	Examiner Timothy D Collins	Art Unit 3643

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

This application is abandoned in view of:

1. ☒ Applicant's failure to timely file a proper reply to the Office letter mailed on 1-16-02.
   (a) ☐ A reply was received on _____ (with a Certificate of Mailing or Transmission dated _____), which is after the expiration of the period for reply (including a total extension of time of _____ month(s)) which expired on _____.
   (b) ☐ A proposed reply was received on _____, but it does not constitute a proper reply under 37 CFR 1.113 (a) to the final rejection. (A proper reply under 37 CFR 1.113 to a final rejection consists only of: (1) a timely filed amendment which places the application in condition for allowance; (2) a timely filed Notice of Appeal (with appeal fee); or (3) a timely filed Request for Continued Examination (RCE) in compliance with 37 CFR 1.114).
   (c) ☐ A reply was received on _____ but it does not constitute a proper reply, or a bona fide attempt at a proper reply, to the non-final rejection. See 37 CFR 1.85(a) and 1.111. (See explanation in box 7 below).
   (d) ☒ No reply has been received.

2. ☐ Applicant's failure to timely pay the required issue fee and publication fee, if applicable, within the statutory period of three months from the mailing date of the Notice of Allowance (PTOL-85).
   (a) ☐ The issue fee and publication fee, if applicable, was received on _____ (with a Certificate of Mailing or Transmission dated _____), which is after the expiration of the statutory period for payment of the issue fee (and publication fee) set in the Notice of Allowance (PTOL-85).
   (b) ☐ The submitted fee of $_____ is insufficient. A balance of $_____ is due.
   The issue fee required by 37 CFR 1.18 is $_____. The publication fee, if required by 37 CFR 1.18(d), is $_____.
   (c) ☐ The issue fee and publication fee, if applicable, has not been received.

3. ☐ Applicant's failure to timely file corrected drawings as required by, and within the three-month period set in, the Notice of Allowability (PTO-37).
   (a) ☐ Proposed corrected drawings were received on _____ (with a Certificate of Mailing or Transmission dated _____), which is after the expiration of the period for reply.
   (b) ☐ No corrected drawings have been received.

4. ☐ The letter of express abandonment which is signed by the attorney or agent of record, the assignee of the entire interest, or all of the applicants.

5. ☐ The letter of express abandonment which is signed by an attorney or agent (acting in a representative capacity under 37 CFR 1.34(a)) upon the filing of a continuing application.

6. ☐ The decision by the Board of Patent Appeals and Interference rendered on _____ and because the period for seeking court review of the decision has expired and there are no allowed claims.

7. ☐ The reason(s) below:

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Petitions to revive under 37 CFR 1.137(a) or (b), or requests to withdraw the holding of abandonment under 37 CFR 1.181, should be promptly filed to minimize any negative effects on patent term.

6/18/01

The below text replaces the pre-printed text under the heading, "Information on How to Effect Drawing Changes," on the back of the PTO-948 (Rev. 03/01, or earlier) form.

INFORMATION ON HOW TO EFFECT DRAWING CHANGES

1. Correction of Informalities -- 37 CFR 1.85

New corrected drawings must be filed with the changes incorporated therein. Identifying indicia, if provided, should include the title of the invention, inventor's name, and application number, or docket number (if any) if an application number has not been assigned to the application. If this information is provided, it must be placed on the front of each sheet and centered within the top margin. If corrected drawings are required in a Notice of Allowability (PTOL-37), the new drawings MUST be filed within the THREE MONTH shortened statutory period set for reply in the Notice of Allowability. Extensions of time may NOT be obtained under the provisions of 37 CFR 1.136(a) or (b) for filing the corrected drawings after the mailing of a Notice of Allowability. The drawings should be filed as a separate paper with a transmittal letter addressed to the Official Draftsperson.

2. Corrections other than Informalities Noted by Draftsperson on form PTO-948.

All changes to the drawings, other than informalities noted by the Draftsperson, MUST be made in the same manner as above except that, normally, a highlighted (preferably red ink) sketch of the changes to be incorporated into the new drawings MUST be approved by the examiner before the application will be allowed. No changes will be permitted to be made, other than correction of informalities, unless the examiner has approved the proposed changes.

Timing of Corrections

Applicant is required to submit the drawing corrections <u>within the time period set in the attached Office communication</u>. See 37 CFR 1.85(a).

Failure to take corrective action within the set period will result in ABANDONMENT of the application.

Rev 01 01

APPENDIX 1

RADIATION VIEW FACTORS

Effective Radiation View Factor

In brief, effective radiation view factor is a measure of the total (i.e. the net, multiple, two-way) radiative coupling per unit area from one body to another body. It is normalised, i.e. numerical value ranges from 0 and 1. It takes no account of the temperatures of the bodies, but can be utilised together with the temperatures in calculating radiative input and output.

Geometric radiation view factors are related factors, and are also known as configuration factors, shape factors, form factors, and angle factors. Definitions may be found in most textbooks on heat transfer. The geometric radiation view factor from surface 1 (emitting surface) to surface 2 (receiving surface) is defined as the fraction of the total radiant flux leaving surface 1 that is incident on surface 2. Numerical value ranges from 0 to 1. It is calculated by assuming that the angular distribution for emission follows Lambert's law; and therefore is only a function of the areas of the two surfaces, their shapes, and relative position. Surface properties, such as emissivity, absorptivity, and temperatures are NOT factors in geometric radiation view factors.

The corresponding effective radiation view factor from surface 1 to surface 2 is the fraction of the total radiant flux leaving surface 1 that is absorbed by surface 2. It includes two more factors: the reflectivity and the absorptivity of the receiving surface. Accordingly, the numerical value of an effective radiation view factor is always less than that of a corresponding geometric view factor in the case of a receiving area with absorptivity less than 1. (Note that for infrared radiation, the values of emissivity and absorbtivity for most materials are practically equal for purposes of aerospace thermal analysis, and accordingly the two values and even the terms emissivity and absorptance are commonly used interchangeably.)

Note that neither effective radiation view factor nor geometric radiation view factor is a function of temperatures of the emitting and receiving surfaces.

Note also, in the present context, that the effective radiation view factor from a thermal radiator surface to space is the (mathematical) complement of the effective radiation view factor from the thermal radiator surface to the associated sun blocker component. Accordingly, the effective radiation view factor from the thermal radiator surface to space is always greater than the corresponding geometrical radiation view factor to space (however, the margin is improved superlatively in the invention according to the disclosure of Reference R1, as discussed throughout herein).

Most importantly in the present context, note that the effective radiation view factor from a thermal radiator surface to space cannot have a high value without means of high performing thermal insulation material located between the front and back surfaces of a sun blocker component, which constitutes the primary factor in cutting the effective

emittance and the infrared absorptance of the backside surface of the sun blocker component to low values.

Please see Appendix 4 for a brief explanation of effective emittance of a surface, and of why the surface emittance of MLI is so low.

Maximising Effective Radiation View Factor

In addition to shading the thermal radiator surface, the sun blocker component should be as "thermally transparent" as possible to the thermal radiator surface, i.e. should radiate minimal heat towards the thermal radiator surface whether that heat arrives at the anti-sun facing surface of the sun blocker component from the sun facing surface or arrives radiatively from the thermal radiator surface itself.

This is achieved by using high performing thermal insulation such as MLI located between the surfaces of the sun blocker component. MLI has not only a very low solar absorptivity (less than 0.05) but also very low effective emittance (less than 0.1), resulting in very little absorption of solar energy at the sun facing surface, very little transfer of energy from the sun facing surface to the anti-sun facing surface, and very little absorption of energy from the thermal radiator surface followed by emission back towards the thermal radiator surface. As a result, the effective radiation view factor to space is not only greater than the corresponding geometric view factor (which would not be unusual) but is greater by a great, very significant, and industrially useful margin.

A sun blocker component according to the disclosure of Reference R1 presents considerable blockage of the geometric radiation view factor from the thermal radiator surface to space: typically 0.35 blockage for a geostationary satellite. The corresponding geometric view factor to space is the (mathematical) complement, i.e. 0.65 for this example. A corresponding effective radiation view factor of approximately 0.95 is achieved using a sun blocker component with generally available multi-layer insulation between the sun facing and anti-sun facing surfaces. (Such MLI has an effective emittance of less than 0.1, and an effective reflectance of 0.9). In contrast, inventions according to prior art achieve corresponding effective radiation view factors lower than 0.87, which we, in light of our considerable sum-total of knowledge and experience at senior thermal-control (and other) engineering levels in the spacecraft industry, hold is a meaningful threshold value below which a design would not be industrially useful.

In conclusion, only the disclosure of Reference R1 specifies and/or claims insulation of the sun facing surface of a sun blocker component from the opposed anti-sun facing surface by means of high performing thermal insulation material. Such insulation has the effect of maximising the effective radiation view factor from the thermal radiator surface to space. Relevant prior art neither mentions nor specifies nor claims such insulation, nor identifies a need for it or a benefit from it, relying instead on entirely different and inadequate techniques, including: a simple shadowing screen, a solar array as a screen, and OSRs or surface finishes on a screen to reduce absorption of solar energy by the screen and consequent radiation of thermal energy to the thermal

radiator surface. The margin of performance of the present invention device over prior art renders prior art obsolete regarding industrial usefulness.

Addressing a Mis-Conception We Encountered Once Previously

It may be helpful for us to address here a misconception that we encountered once previously. i.e. that if the temperature of the anti-sun-facing side of a sun blocker component (which in Cited Document D1 is the solar array) is less than the temperature of the thermal radiator surface, then the effective radiation view factor from the thermal radiator surface to space is greater than the corresponding geometric view factor. However, the effective radiation view factor from one object to another is a function of only surface properties, dimensions and configuration, and NOT a function of temperatures of the objects.

In fact, regardless of the temperature of the thermal radiator surface, any heat that passes through the sun blocker component from the sun facing surface to the the anti-sun facing surface will act as an undesired heat source, radiatively heating the thermal radiator surface and reducing its heat rejection capability.

APPENDIX 2

EXTRACTS FROM THE DISCLOSURE OF REFERENCE R1 AND THE PRIORITY DOCUMENT

In Priority Document (USPN 6,102,339 to Turbosat Technology, Inc.) As Filed

p19, ll4-8
......the material or design selected for the blocking device, which will be discussed below, shall have heat insulation characteristics between the front (sun side) and back side of the blocking panel......

p21, l15 – p22, l3
The material or the configuration of the blocking panel shall have a heat insulation characteristic between its sun side and the opposite-sun side in order to provide minimum "effective" radiation view factor blockage to the north or south panels.

p33, l10 – p34, l7
The material used for the sun blocking panels 111 and 112 shall minimize the heat transferred from their sun facing surfaces 111a and 112a to their back-to-sun surfaces 111b and 112b. The insulation material may be known insulative materials such as composite materials utilizing Mylar and fabric to make a multi-layer insulation (MLI). These materials are well known in the space industry. The sun blocking panels of the present invention generally create a sizable temperature difference (e.g. may be more than 100°C) between surface 111a and surface 111b when the satellite is operating in normal attitude in the orbit (except when the satellite is in the eclipse of earth).

In the Disclosure of Reference R1 As Filed

p3/0/2, l30 – p3/0/3, l6
...........the materials and design selected for the sun ray blocker device, which will be discussed below, should ideally provide .... high insulation of heat between the front (sunward) and back (anti-sunward) sides of the sun ray blocker device

p4/1, ll1-12
...........said sun blocker component being adapted for achieving a high radiation view factor from the thermal radiator surface to deep space by means including thermal insulation material located between the sun-facing surface and the opposed surface for restricting heat flow through said sun blocker component between said sun-facing surface and said opposed surface.
Conveniently, the sun-facing surface is thermally insulated from the opposed surface by multi-layer insulation (MLI).

p24,l l15-11

The material and/or the construction of the sun blocker component of the sun ray blocker device is preferably highly thermally insulating between its sun and anti-sun sides in order to provide the greatest practical effective radiation view factor and radiative efficiency of the radiator-surface shielded by the sun blocker component.

P36, ll13-33

The materials used for the sun blocker components 111 and 112 are selected to minimize the heat transferred from their sun facing surfaces 111a and 112a to their anti-sunward surfaces 111b and 112b. This may be achieved by including insulating material(s) and constructions in the composition of the sun blocker components. For example, sun blocker components may include known thermally insulating materials and assemblies of materials, such as multi-layer insulation (MLI) blankets which utilize layered films of metallized Mylar separated by fabric netting. These materials and constructions are well known in the space industry and have typical heat resistance values of 0.007 to 0.01 Watt/deg.C/sq.in, i.e. 0.0011 to 0.0016 Watt/deg.C/sq.cm. The sun blocker components of the present invention device will generally experience a sizeable temperature difference, for example possibly greater than 100 degree C, between surface 111a and surface 111b and between surface 112a and surface 112b when the satellite is in its normal orientation in the mission orbit, except when the spacecraft is passing through the Earth's shadow.

Claims 1 and 2

A spacecraft for orbiting a sunlit celestial body (300), the spacecraft including a thermal radiator surface (11,12,1804, 2121, 2721) for radiating heat from the spacecraft into space, and a sun ray blocker device (581, 582, 681, 682) mounted on said spacecraft for shielding said thermal radiator surface (11,12,1804, 2121, 2721) from rays of sunlight, characterised in that said sun ray blocker device (581, 582, 681, 682) includes at least one sun blocker component (111, 112, 271, 301, 411,511, 611, 811,921, 951, 1800, 2100, 2700, 3100, 3200), said sun blocker component being locatable, in an operational configuration, on a sun line from said thermal radiator surface (11,12,1804, 2121, 2721) and being of suitable shape, size, and orientation for placing in shadow up to the whole of said thermal radiator surface (11,12,1804, 2121, 2721) from sunlight, said sun blocker component having a surface (111a, 112a) intended to face the Sun in use and an opposed surface (111b, 112b) intended to face away from the Sun in use, said sun blocker component (111, 112, 271, 301, 411,511, 611, 811,921, 951, 1800, 2100, 2700, 3100, 3200) being adapted for achieving a high radiation view factor from the thermal radiator surface (11,12,1804, 2121, 2721) to deep space by means including thermal insulation material located between the sun-facing surface (111a, 112a) and the opposed surface (111b, 112b) for restricting heat flow through said sun blocker component (111, 112, 271, 301, 411,511, 611, 811,921, 951, 1800, 2100, 2700, 3100, 3200) between said sun-facing surface (111a, 112a) and said opposed surface (111b, 112b).

2. A spacecraft as claimed in claim 1, wherein the sun-facing surface (111a, 112a) is thermally insulated from the opposed surface (111b, 112b) by multi-layer insulation (MLI).

APPENDIX 3

COMPARISON OF HEAT REJECTION PERFORMANCE OF THERMAL RADIATOR SURFACE WITH SUN BLOCKER COMPONENT OF VARIOUS MATERIALS

Appendix 3

Comparison of Heat Rejection Performance of Thermal Radiator Surface with Sun Blocker Component of Various Materials

Case No.	Season	Characteristics of Blocker Material	Surface Properties (α/ε) of Characteristics Material	Effective Properties (α/ε) of Characterastics Material	Sun Side Temp.(°C) of Blocker	Backside Temp. (°C) of Blocker	Temp (°C) of North Radiator	Temp (°C) of South Radiator	Improvement in Heat Rejection Capability of Radiator Surface (normalized with respect to MLI)
1	Winter Solstice Summer Solstice Equinox	No blocker	N/A	N/A	N/A N/A N/A	N/A N/A N/A	26 47 24	50 25 24	0%
2	Winter Solstice Summer Solstice Equinox	Single Skin w. Polished Aluminum	0.35/0.04	0.35/0.055	82 74 77	81 73 76	51 48 50	51 48 50	-5%
3	Winter Solstice Summer Solstice Equinox	Single Skin w. White Paint	0.5/0.8 (End of Life)	0.3/0.8 (End of Life)	35 31 33	34 30 32	41 39 40	41 39 40	43%
4	Winter Solstice Summer Solstice Equinox	OSR surface on Outer Layer	0.28/0.78 (End of Life)	0.28/0.9 (End of Life)	21 17 19	19 15 16	35 33 34	35 33 34	70%
5	Winter Solstice Summer Solstice Equinox	Honeycomb Core (Multi-Layer)	0.8/0.9	0.55/0.9	49 45 47	35 32 33	42 40 41	42 40 41	39%
6	Winter Solstice Summer Solstice Equinox	Graphite epoxy Laminate (Multi-Layer)	0.8/0.9	0.55/0.9	49 45 47	32 29 30	41 40 40	41 40 40	43%
7	Winter Solstice Summer Solstice Equinox	3 Layers of Mylar Sheets (no separator)	0.7/0.7	0.25/0.3	98 91 94	21 18 19	39 36 37	39 36 37	53%
8	**Winter Solstice Summer Solstice Equinox**	**Multi-Layer Insulation (CURRENT INVENTION)**	**0.7/0.7**	**0.05/0.1**	**120 117 118**	**-48 -50 -50**	**28 26 27**	**28 26 27**	**100%**

The invention according to the disclosure of Reference R1, with MLI between the surfaces of the sun blocker component, is novel, inventive, industrial useful, and inherently superior in performance.

APPENDIX 4
MLI, AND EFFECTIVE EMITTANCE

The effective emittance of a surface has been well defined in reference book ("Principles of Communications Satellites", by Gary Gordon and Walter Morgan, publisher John Wiley and Son, 1993, pp 418, 419). It is the net or equivalent emissivity of a surface that takes into account multiple thermal couplings between the surface and its surroundings. For a simple skin, as called out in Cited Document D4, the effective emittance is the same as the emissivity of its outer surface; whereas the value of effective emittance for multi-layer insulation (MLI), for example, is given by the following equation:

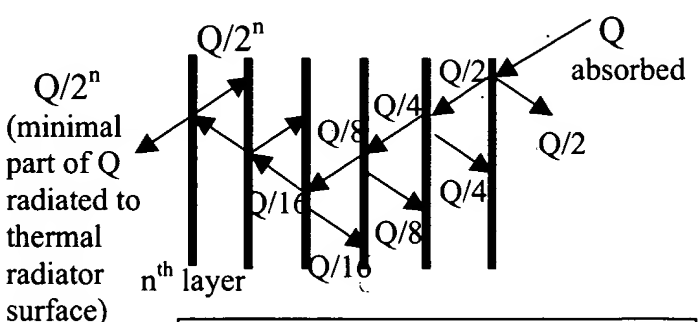
$1/\varepsilon_{eff} = 1/\varepsilon_t + 2n/\varepsilon - n$ (Equation 16.27, p 419, Ref. book)

Where ε_{eff} is the effective emittance
ε_t is emissivity of outer surfaces of the MLI
ε is the emissivity of internal surfaces of the MLI
n is the number of layers in the MLI

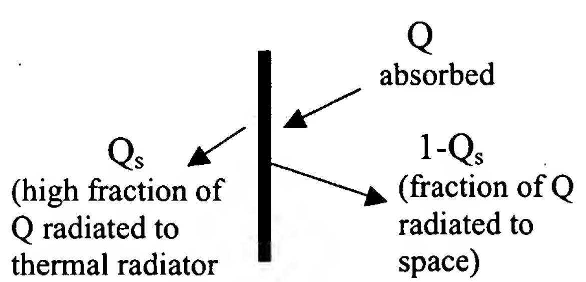
For 12-layer MLI made of Mylar sheets (ε ranging from 0.3 to 0.5) with Dacron net separators, the theoretical ε_{eff} is less than 0.01. Regarding a single skin, typical coatings have end of life (EOL) (i.e. after exposure to the space environment) emissivities ranging from 0.5 to 0.7 (i.e. 50 to 70 times higher than ε_{eff} MLI, which hardly degrades with time in space).

Accordingly, with regard to the back side of a sun blocker component, ε_{eff} for MLI is much lower than ε_{eff} for the simple skin option of Cited Document D4. Moreover, while such a simple skin with external coatings would reduce absorbed solar energy on the sun side somewhat, it would also transfer absorbed solar energy directly to its backside by conduction, resulting in undesired heating of the thermal radiator surface.

Consider, for example, MLI in which the emissivity of each side of each layer is equal. Energy absorbed by any layer is subsequently emitted, half from each of the opposed surfaces of the layer. Consequently, MLI transfers minimal heat to its far side. In comparison, a single skin, even with a low emissivity external coating, is greatly inferior to MLI, transfering half of the absorbed energy to the its side. Furthermore, such external coatings degrade with exposure to the space environment, as their emissivity increases, and they absorb more solar energy.



n-layer Multi-Layer Insulation



Simple Skin with Exterior Coatings

APPENDIX 5

ANALYSIS OF A SENTENCE IN CITED DOCUMENT D4

Appendix 5 presents observations and conclusions drawn from an analysis of a sentence in Cited Document D4 (in p 2, col 2, ll 32-36). The subject sentence is "***Il peut être constitué d'une matière multicouche ou d'une simple peau avec des revêtements externes adequats, destinés à limiter les effets du soleil sur celui-ci, donc sur les surfaces radiatives, et à augmenter leurs capacités de rejet....***" (*It can consist of a multi-layer material or of a simple skin with suitable external coatings, destined to limit the effects of the Sun on the latter, therefore on the radiative surfaces, and to increase their (heat) rejection capabilities....*)

1. First, the subject sentence mentions two optional structural compositions of the screen, differing only in that the substrate or structural element of the screen is either "***...une matière multicouche ou...une simple peau ...***" (*...a multi-layer material or...a simple skin...*). Cited Document D4 provides no information regarding specific materials or specific thermal-related constructions or specific thermal-characteristics or specific thermal functions for either of said two optional substrates or structural elements per se, or even for their external coatings, and in particular nothing specific with regard to insulation (i.e. impedance of passage of thermal energy) between the front (sun facing) surface of the screen and the opposed back surface by any constituent element of the screen.

2. Seeking to identify the thermal related purpose stated by the subject sentence, we note that the stated intention is "***....à limiter les effets du soleil ....sur les surfaces radiatives, et à augmenter leurs capacités de rejet....***" (*....to limit the effects of the Sun....on the radiative surfaces, and to increase their (heat) rejection capabilities....*).

   It appears that said "***....surfaces radiatives....***" (*....radiative surfaces....*) are the exterior surfaces of the grammatical subject of (a) the subject-sentence, and (b) the preceding sentence, and (c) the inclusive paragraph, i.e. of the sun facing and anti-sun facing surfaces of the screen. We note that in the system as described there is also a radiative surface (used as a thermal radiator) located on the body of the satellite, and also radiative surfaces on the solar array. Note, however, that Cited Document D4 refers to the thermal radiator located on the body of the satellite as "***....une face utilisée en radiateur thermique pour les équipements embarqués a bord dudit satellite....***" (*....a side used as a thermal radiator for the equipment carried on board said satellite....*), i.e. using different expressions "***....une face....en radiateur thermique....***" (*....a side....as a thermal radiator....*), and also in the singular not the plural.

Accordingly, said "***....surfaces radiatives....***" (*....radiative surfaces....*) include at least the sun facing and anti-sun facing surfaces of the screen. However, the only way that the screen can be designed to increase the heat rejection capability of said surfaces of the screen is to include high emissivity external coatings – which concomitantly has the adverse effect of increasing the fraction of incident solar energy that the screen absorbs.

3. Secondly, it appears that the clause "***Il peut être constitué d'une matière multicouche ou d'une simple peau avec des revêtements externes adequats ...***" (*It can consist of a multi-layer material or of a simple skin with suitable external coatings...*) may be ambiguous in that:

    (a) it appears that said clause may be interpreted to mean that the single phrase "***...une simple peau...***" (*...a simple skin...*) alone is qualified by the immediately subsequent phrase "***...avec des revêtements externes adequats, destinés à limiter les effets du soleil sur celui-ci,....***" (*...with suitable external coatings, destined to limit the effects of the Sun on the latter,...*).

    (b) and additionally it appears that said clause may be interpreted to mean that each of the two phrases "***...une matière multicouche...***" (*...a multi-layer material...*) and "***... une simple peau...***" (*...a simple skin...*) in the optional phrase "***...d'une matière multicouche ou d'une simple peau...***" is individually qualified by the subsequent phrase "***...avec des revêtements externes adequats, destinés à limiter les effets du soleil sur celui-ci,....***" (*...with suitable external coatings, destined to limit the effects of the Sun on the latter,...*)..

4. It appears that in either of interpretations n^os^. 3(a) and 3(b) preceding, the word "***...destinés...***" (*...destined...*) qualifies only the preceding phrase "***...des revêtements externes adequats...***" (*...suitable external coatings...*).

    [To readily illustrate the point of the first sentence of this section 3, consider the particular agreement of gender and singularity/plurality in the analagous phrase "*...Il peut être constitué d'une femme ou d'une fillette avec des chapeaux, destinés ...*", i.e. "*...It can consist of a woman or of a girl with hats (masculine, plural), destined (masculine, plural) to...*". Clearly, the phrase "*...une femme ...*" (*...a woman...*) alone is certainly treated as feminine singular. Secondly, because the subsequent phrase is "*...une fillette* <u>*avec*</u> *des chapeaux...*" (*...a girl* <u>*with*</u> *hats...*) and <u>not</u>, for example, "*...une fillette* <u>*et*</u> *chapeaux...*" (*...a girl* <u>*and*</u> *hats...*), the phrase "*...une fillette avec des chapeaux ...*" (*...a girl with hats...*) alone is still treated as feminine singular. This confirms that the masculine plural word "*...destinés ...*" (*...destined...*), qualifies the masculine plural word "*...chapeaux ...*" (*...hats...*). Note that

even if the word "*...destinés ...*" did qualify "*...une femme ...*" (*...a woman...*) or "*...une fillette ...*" (*...a girl...*), then it would have to be not only feminine but also feminine singular because of the effect of the word "*...ou ...*" (*...or...*). However, as stated earlier, "*...destinés ...*" (*...destined...*) is masculine plural.]

4.1. Accordingly, consequences of interpretation nº. 3(a) preceding, are that:

(a) any thermal control of a screen mentioned in Cited Document D4 is achieved only for a screen consisting of a simple skin with external coatings, and
(b) said thermal control of the screen is achieved only by virtue of said external coatings, and
(c) concerning a screen consisting of only a multi-layer material,
 (i) Cited Document D4 clearly neither provides nor indicates any thermal-related information whatsoever, and
 (ii) thermal control of the screen is either not a feature of the invention or is unspecified and unclear, and
 (iii) if any thermal control of the screen were intended but not specified, that thermal control would most reasonably have been by means of unspecified external coatings, which are the only means of thermal control of a screen mentioned anywhere in Cited Document D4 – and accordingly interpretation nº. 2(b) preceding would be correct.

4.2. Also accordingly, consequences of interpretation nº. 3(b) preceding, are that any thermal control of a screen achieved by virtue of either of the two optional structural compositions of the screen is achieved only by virtue of said "***...revêtements externes adéquats...***" (*...suitable external coatings...*), and not by virtue of the multi-layer material per se or the simple skin per se, i.e. not by virtue of the substrate or structural element of the screen, and therefore not by virtue of the material or construction of the substrate or structural element.

4.3. Also accordingly, the description, and the description only, in Cited Document D4 provides merely a nonspecific statement of thermal-related intent; and the only means mentioned for achieving said intent are also nonspecific "*...**revêtements externes adéquats...***" (*...suitable external coatings...*). Furthermore, the meaning of "***...adéquats...***" (*...suitable...*) is not provided and neither are any physical characteristics or specific thermal characteristics of such "***...revêtements externes adéquats...***" (*...suitable external coatings...*).

4.4. As a consequence, there is no precise definition, in whatsoever location, within Cited Document D4 of
 - what particular "***...revêtements externes ...***" (*...external coatings...*) might conceivably be incorporated into a screen, nor

- specifically how the external coatings might limit the effects of the Sun on the screen, nor
- to what degree said unspecified limiting of the effects of the Sun might be achieved.

5. It appears to us, therefore, that the alleged feature in the description of Cited Document D4 is merely a statement of intent, and has no technical meaning, especially as the word "***...adéquats...***" (*...suitable...*) adds a further measure of imprecision to the statement, rendering said description unclear.

APPENDIX 6

BRIEF DISCUSSION OF ABSORPTIVITY, EMISSIVITY AND REFLECTIVITY OF SUN BLOCKER SURFACES

The regular heat radiation heat transfer theorem for radiant thermal energy incident on a surface of a material is generally written in the form

$$\alpha + \tau + \rho = 1 \qquad (1)$$

where

α is the absorptivity, ε is the emissivity, τ is the transmissivity, and ρ is the reflectivity at the surface.

Note that for a given wavelength, the values of α and ε are very close to equal for most spacecraft materials, i.e.

$$\alpha = \varepsilon \qquad (2)$$

Accordingly, substituting for α in (1) from (2) gives

$$\varepsilon + \tau + \rho = 1 \qquad (3)$$

In fact, since much of the non-solar radiant energy involved in thermal-control engineering for spacecraft surfaces is in the infrared (i.e. is at wavelengths of the order of 10 μm) it is a convention in spacecraft thermal-control engineering to represent <u>both</u> the infrared absorptivity and the infrared emissivity by the symbol ε and to reserve the symbol α for the value of absorptivity at solar wavelengths, which are predominantly in the visible part of the electromagnetic spectrum (i.e. are of the order of 0.5 μm). Note, however, that the value of absorptivity for solar energy (i.e. for visible wavelengths) is generally quite different the value of absorptivity for infrared energy.

Consequently, in spacecraft thermal-control engineering of a surface both exposed to solar energy and facing deep (cold) space it is usual to consider absorption of solar energy with a factor α (which tends to raise the temperature of said surface) and emission of thermal energy (in the infrared) with a factor ε (which tends to lower the temperature of said surface).

Accordingly, in both the disclosure of Reference R1 and the present letter, the word emissivity and the symbol ε are used for both absorptivity and emissivity at infrared wavelengths, whereas the word absorptivity and the symbol α are used for absorptivity at the wavelengths (visible) of solar energy.

(For reference, typical values of α and ε for several well known surfaces are listed in Table 16.2, page 409 of textbook "Principles of Communications Satellites", by Gary D. Gordon and Walter L. Morgan, John Wiley & Sons, Inc. 1993.)

Furthermore, in spacecraft thermal-control engineering the value of the ratio α/ε is used as an index of the ratio of the energies absorbed and radiated to deep

space by a surface exposed to solar illumination. Higher values of α/ε signify higher surface temperature, as a result of more energy absorbed and less emitted. Lower values of α/ε signify the opposite. Practical values of the ratio α/ε are typically between 0.1 and 10.

Value of α and ε are applicable to both true surface properties and effective surface properties of thermal control materials such as multi-layer insulation (MLI).

APPENDIX 7

FILLED OUT INFORMATION DISCLOSURE STATEMENT (IDS)

PTO/SB/08A (10-01)
Approved for use through 10/31/2002. OMB 0651-0031
U.S. Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(use as many sheets as necessary)

Sheet	1	of	2

Complete if Known	
Application Number	09/673,559
Filing Date	02/22/2001
First Named Inventor	Albert T. Wu
Art Unit	3643
Examiner Name	Timothy D. Collins
Attorney Docket Number	

U.S. PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Document Number: Number - Kind Code[2] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
		US- 5527001	06-18-96	Stuart, James R	
		US-			
		US-			
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		US-			
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FOREIGN PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Foreign Patent Document: Country Code[3] -Number[4]- Kind Code[5] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear	T[6]
		EP0447049	09-18-1991	Banfield Lyndon		
		EP0271370	06-15-1988	Dupuis Yves		
		EP0887260	12-30-1998	Bard Max		

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] Applicant's unique citation designation number (optional). [2] See Kinds Codes of USPTO Patent Documents at www.uspto.gov or MPEP 901.04. [3] Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). [4] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [5] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST. 16 if possible. [6] Applicant is to place a check mark here if English language Translation is attached.

PTO/SB/08B (10-01)
Approved for use through 10/31/2002. OMB 0651-0031
U.S. Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Substitute for form 1449B/PTO				Complete if Known	
INFORMATION DISCLOSURE STATEMENT BY APPLICANT				Application Number	09/673,559
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				First Named Inventor	Albert T. Wu
				Group Art Unit	3643
(use as many sheets as necessary)				Examiner Name	Timothy D. Collins
Sheet	2	of	2	Attorney Docket Number	

OTHER PRIOR ART -- NON PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No.[1]	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[2]
		FORTESCUE P W, STARK J P W: "Spacecraft Systems Engineering", 1990, WILEY & SON, CHICHESTER, UK, p. 280 – p. 284; table 12.5; p. 288 – p. 293	

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[1] Applicant's unique citation designation number (optional). [2] Applicant is to place a check mark here if English language Translation is attached.

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AMENDMENTS

- EXCHANGE PAGE 31 IN RESPONSE TO DETAILED ACTION IN REFERENCE R3;
- EXCHANGE PAGE 59/1;
- EXCHANGE PAGE 65;
- NEW PAGE 60/0/1.

with the sun blocker device folded and deployed, respectively;

FIGURES 17a, b, and c show a different alternative present-invention device in the same views and deployed states as those shown in FIGURES 16a, b, and c;

FIGURE 18 shows a further embodiment of the invention;

FIGURE 19 shows another embodiment of the invention;

FIGURE 20 shows another embodiment of the invention;

FIGURES 21, 22, 23, 24, and 26 show another embodiment of the invention;

FIGURE 25 shows details of the embodiments of FIGURES 21 and 24 and 26;

FIGURES 27, 28, 29, and 30 show another embodiment of the invention; and

FIGURES 31 and 32 illustrate alternative shapes for sun blocker components used in the present invention.

arm (2130, 2730) for attachment of the sun blocker component to the spacecraft.

16. A spacecraft as claimed in claim 15, wherein the attachment arm is a scissors arm (2730).

17. A spacecraft as claimed in claim 15, wherein the attachment arm (2130) is formed of articulated portions (2132, 2134, 2137) which may be mutually articulated

tracking movement of the solar cell array, when in normal operation.

ABSTRACT

SPACECRAFT

A spacecraft having a sun ray blocker device (581, 582, 681, 682) for shading a thermal radiator surface (11,12, 1804, 2121, 2721) of the spacecraft in which the sun ray blocker device is movable in relation to the thermal radiator surface to keep the surface substantially in shade without substantially blocking thermal radiation from the thermal radiator surface to deep space. Preferably a sun-facing side (111a, 112a) of the sun ray blocker device is thermally insulated from an opposed side (111b, 112b) to reduce thermal radiation from the sun ray blocker device to the thermal radiator surface and the sun ray blocker device is also preferably deployable in orbit after launch.

TRANSLATIONS OF CITED FOREIGN-LANGUAGE DOCUMENTS

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(54) Satellite with improved thermal rejection

(57) -The current invention concerns a satellite, notably geostationary, comprising:

- at least one face (5) utilized as a thermal radiator for the equipment carried on board said satellite (1) and arranged in the path of solar radiation (9);
- at least one solar panel (7) as generator of electricity, constantly oriented towards the sun and projecting from said face (5); and
- a screen (14) attached to said solar panel (7), positioned to the edge of said satellite and blocking the solar radiation (9) directed towards the said face.

- According to the invention, this satellite is remarkable in that:

- the said solar panel (7) is positioned centrally with respect to the said face (5); and

- the said screen (14) is attached to the said solar panel (7) by the intermediary of an arm (15).

Description

The present invention concerns satellites, notably geostationary, and, more particularly, the thermal control of said satellites.

It is known that the electronic equipment carried on board satellites dissipates energy in a thermal form. To maintain said equipment in an optimal band of temperature for functioning, it is therefore necessary to remove the surplus thermal energy, to the exterior of the satellite. It is known also that such removal of thermal energy is in general obtained by radiation towards space.

In the case of a satellite, notably a telecommunications satellite, comprising a north face and a south face, opposing one another and respectively orthogonal to the polar axis of the Earth, it is usual that the radiation of the heat of the satellite towards space is effected by the said north and south faces, utilizing thermal radiators. Such a process of removal of heat is advantageous, as the said north and south faces:

- sustain, on an annual cycle, a minimal insolation as compared with other faces of the satellite; and
- have a constant solar illumination through a day, that is to say during a revolution, which allows avoidance of excessive temperature variations.

However, due to the same fact of the solar illumination that delivers thermal energy to said north and south faces, the removal of heat by them cannot be optimal and could even be insufficient to assure an adequate functional temperature for said equipment.

This drawback is all the more pronounced because generally, in a simple and known manner, the radiative surfaces of said north and south faces – radiative surfaces which are the basis of thermal control of the satellite – are protected by a solar reflective surface that has high infrared emissivity, such as OSR (Optical Surface Reflector), covering the said faces at least partially. In effect, such a surface absorbs a non-negligible part of the incident solar power and therefore presents a limited capacity for thermal rejection. Furthermore, the OSR surfaces present the additional drawbacks of being costly and being sensitive to aging under the effect of solar radiation.

To increase the thermal rejection capacity of a satellite, the document EP-A-O 447 049 proposes using the solar panels themselves, to permanently cast their shadow on such a face of a satellite, regardless of the position of the Sun, so that its temperature is lowered and the thermal rejection capacity of the said face is increased.

However, such a known manner of realisation means that the said solar panels have to be offset, which raises difficulties with commanding, balancing and rotating the said solar panels.

The aim of the present invention is to remedy this disadvantage.

To this end, according to the invention, the satellite, notably geostationary, comprising:

- at least one face utilizing a thermal radiator for the equipment carried on board said satellite and located in the path of solar radiation;
- at least one solar panel as generator of electricity, constantly oriented towards the Sun and projecting from the said face; and
- a screen attached to said solar panel, located at the edge of said satellite and blocking the solar radiation directed towards the said face, is remarkable in that;
- the said solar panel is located centrally with respect to the said face; and
- the said screen is attached to the said solar panel by the intermediary of an arm.

It is understood that the height and size of said screen, just as its distance from the solar generator, are determined so that the shadow that it casts on the said face corresponds at least to the desired rejection capacity.

Such a screen can have a simple form or an optimised profile, it can be one single piece or made from several elements. It can be made from a multi-layer material or a single skin with suitable external coatings, destined to limit the effects of the sun on the latter, therefore on the radiative surfaces, and to increase their rejection capacities. During the launch phase, the screen can already be in an operational or folded phase and in this case its deployment can be automatic or controlled.

It stands to reason that the form of the satellite platform can be any, that the screen can be in line with, inside or outside it, and it can also go beyond the satellite or not.

Such a link arm between the screen and the solar panel can be a specific component or be integrated into the generator or the screen. It can be fixed to whatsoever part of the solar generator. However, advantageously, it is solid with the foot of the said solar panel.

The said radiative face of the satellite can be planar and covered at least partially with a highly emissive surface.

As mentioned previously, such a radiative face can be the north face or the south face of the said satellite.

The invention will be better understood using the figures in the attached drawing. In the figures, identical references are used for

similar elements.

Figure 1 illustrates a satellite in its geostationary orbit.

Figures 2 and 3 schematically and partially illustrate in side view and plan view, respectively, an implementation of a satellite according to the invention.

In Figure 1, a geostationary satellite 1 is schematically represented in its orbit 2 around the Earth 3. The platform 4 of satellite 1 presents, for example, a parallepiped shape and it comprises a north face 5 and a south face 6 perpendicular to the polar axis of the Earth.

Solar panels 7 and 8 are provided to supply satellite 1 with electric energy and are permanently directed towards the sun from which they receive radiation 9. Solar panels 7 and 8 are located centrally and project, respectively from the north face 5 and the south face 6, for example thanks to feet 10 or 11 becoming solid with the said panels 7 and 8 of platform 4. In a known manner, the said feet 10 and 11 are articulated to allow the said panels 7 and 8 to adopt a folded position along the platform 4 during the launch of the satellite 1 and a deployed position (that shown in figure 1 and described hereinabove) when the said satellite is put in its orbit 2.

Moreover, also in a known manner, feet 10 and 11 can turn around a Z-Z axis (see curved arrows 12 in figures 2 and 3) which are orthogonal to the said north and south faces 5 and 6, so that the said solar panels 7 and 8 can be permanently oriented towards the sun (radiation 9) under the action of a servo-control positioning device (known and not shown) located in platform 4.

The thermal control of satellite 1 is obtained by utilizing the north and south faces 5 and 6 as thermal radiators, as has been explained previously. To this end, these faces carry an emissive surface 13, which cover at least part of and form the radiative surface of the said faces (see Figures 2 and 3).

According to the present invention, and as is represented in Figures 2 and 3 with respect to the north face, a screen 14 is provided, arranged at the periphery of the platform 4 of the satellite and arranged in the path of the solar radiation 9 so that its shadow that is cast on the face 5 entirely covers it, or at least its emissive surface 13.

The screen 14 is solid with foot 10 on the solar panel 7 by means of an arm 15.

The position and the form of the screen 14 are planned so that the latter can move in rotation around axis Z-Z, with the said solar panel 7, depending on the orientation of the solar radiation 9, in order to have its shadow permanently on the said face 5, or at least the coating 13.

Claims

1. Satellite, notably geostationary, comprising:
- at least one face (5) used as thermal radiator for equipment loaded on board the said satellite (1) and located in the path of the solar radiation (9);
- at least one solar panel (7) generating electricity, constantly oriented towards the sun and projecting from the said face (5): and
- a screen (14) solid with the said solar panel (7), located on the periphery of the said satellite and stopping the solar radiation (9) directed towards the said face (5),

characterised in that:

- the said solar panel (7) is located centrally in relation to the said face (5); and
- the said screen (14) is made solid with the said solar panel (7) by means of an arm (7).

2. Satellite according to claim 1, characterised in that the said arm (15) is solid with the foot (10) of the said solar panel (7).

3. Satellite according to either of claims 1 or 2, characterised in that the said face (5) is coated at least partially by a coating with high infra-red emissivity (13).

4. Satellite according to any of claims 1 to 3, characterised in that the said face (5) is the north face of the platform (4) of the said satellite.

5. Satellite according to any of claims 1 to 4, characterised in that the said face is the south face of the platform (4) of the said satellite.

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(54) Sun shade device for geostationary satellite

(57) It comprises a screen (5) on a crown (4) rotated by a motor ending in a pinion (8) so as to orient the screen (5) in the direction (S') of the Sun. It protects from solar radiation a radiator (3) designed to cool observational sensors (1) working in the infrared.

Description

SUN SHADE DEVICE FOR A GEOSTATIONARY SATELLITE

The present invention concerns a sun shade device useable on geostationary satellites whose orientation with respect to the Sun varies in a regular and continuous manner through the day.

A problem that arises in practice with these satellites is the continuous cooling of infrared sensors used in the observation of the surface of the Earth. A method used to this end consists of connecting the different sensors to a radiator that continuously removes the heat so as to notably lower their temperature. One is therefore in the presence of a passive system functioning without maintenance, which is evidently particularly attractive on a satellite which possesses limited energy resources and whose lifetime can be long. To be effective the radiator must be arranged so as never to be struck by solar radiation; for this reason the radiators have already been arranged on surfaces whose normal is oriented in an orthogonal fashion to the plane of the terrestrial equator, towards the north or towards the south (one will talk, therefore, of polar orientation in the text). This arrangement needs, nevertheless, to be improved upon, as through the course of a year the position relative to the Sun with respect to the plane of the terrestrial equator varies and it is difficult to avoid the radiator being affected at the time of one of the solstices.

The present invention permits remediation of this drawback with the help of a sun shade device orientable in a continuous manner as a function of the position of the Sun with respect to the satellite and of dimensions sufficiently reduced to not diminish too greatly the solid angle defining the sky of the radiator. One maintains, thus, a sufficiently large black surface while still protecting itself against the effects of parasitic energy.

A sun shade screen for geostationary satellite has been described in the patent EP-A-O 132 768. It is a question, however, of a half right-cylinder of sufficient height designed to cover the surface of a specific cylindrical sector of a satellite while still favourably orienting the solar panels; it must therefore possess a sufficient mechanical resistance. On the other hand, the instruments situated just above this screen, on the polar face, are still exposed to solar radiation.

A simple axial translation of this screen does not lead to a satisfactory result as it would envelop the radiator too much.

To this end, the invention therefore has as an objective a sun shade device for geostationary satellite, comprising a crown arranged around a zone protected from solar radiation, means of positioning the crown permitting its rotation around an axis of the satellite orthogonal to the plane of the terrestrial equator, means of rotating this crown and a screen reflecting the solar radiation, fixed on the crown and extending around an angular sector of it, characterised in that the protected zone has a polar orientation and in that the screen widens out in proceeding away from the crown and presents a variable height along its circumference.

According to a possible embodiment of the invention, the means of rotating the crown comprise a stepper motor provided with a toothed wheel, which engages with corresponding teeth on the crown.

The solar-light reflective surfaces comprise a polished aluminium sheet and, on the exterior of it, a layer of material assuring the thermal insulation and the reflection of the solar light.

The invention will now be described in a more concrete and precise manner with the aid of commentaries on the drawings provided in the annex, among which:

- Figure 1 represents the general configuration of a geostationary satellite with respect to the Earth and the Sun;
- Figure 2 represents a perspective view of a geostationary satellite equipped with the invention;
- Figure 3 represents a detail of the invention; and
- Figure 4 schematically represents a variant implementation of a screen according to the invention.

Figure 1 essentially represents the Earth Te, the geostationary satellite St and the Sun So. The locality of the geostationary satellite is a circle in the plane of the terrestrial equator Eq and 35, 800 km distant from the surface of the Earth Te; by definition it travels around this circle in twenty four hours and the drawing represents it in the position where it is aligned with the Earth Te and the Sun So and in-between them. The satellite St therefore generally presents a lateral surface L whose area is swept every twenty four hours by the solar radiation and two extreme surfaces N and S parallel to the plane of the terrestrial equator and not exposed to the Sun So. It is on these surfaces N and S that it would be advantageous to place radiators designed to disperse heat form the infrared sensors of the satellite St. But the idea loses its attractiveness when the surface upon which the radiator is located corresponds to the terrestrial winter hemisphere: the solar radiation in that case illuminates this surface N or S and, even if the rays arrive with a very oblique incidence, the functioning of the radiator is not perturbed less by it.

Figure 1 summarises this state of affairs by indicating, by a reference line between the Earth Te and the satellite St, the path of sun rays Hn and Hs at the times of the June and December solstices.

Figure 2 represents the satellite St which is provided with a battery of infrared sensors 1, for example the infrared sensors utilised for meteorological observations and situated in the focal plane of an instrument 2 pointed towards the Earth. The heat that these sensors accumulate and transmit towards a radiator 3 which consists principally of a surface placed near to the north face N (or south

S) of the satellite ST and therefore radiating to space.

The direction of the Earth is represented by the axis T and the direction of the Sun by the axis S'; the projection of this axis S' in the plane of the terrestrial equator, perpendicular to the polar orientation, is the axis S''.

A sun shade screen 5 is oriented in the direction S'' and turns continuously as a function of the angle G made by the axes S and T. A fixed sun shade entirely enveloping the radiator 3 would have indeed too greatly reduced the solid angle through which the radiator 3 dissipates the heat that it receives. It is on the other hand desirable that the size of the sun shade screen be as reduced as possible.

The sun shade screen 5 is, according to a preferred embodiment of the invention, in the form of a portion of an oblique cylinder or trunk of a cone provided with a crown 4 provided with a toothed circumference 17 as a base and whose superior contour 5' lies in a plane intersecting the plane of this crown 4. The sun shade screen 5 therefore has a varying height, greater in the central part more especially exposed to the Sun and diminishing towards the extremities. On obtains finally a form which widens (?) in moving away from (?) the crown 4 and blocks much less of the sky of the radiator 3 than would a half right-cylinder.

In a possible embodiment, one could employ a screen spreading angularly through 180°, constructed from a cylinder slanting at 30° with respect to the polar orientation or a cone of 30° half angle of opening, and of maximum height (projected orthogonally on to the polar orientation) of 100 mm for a radiator of 250 mm diameter. This form is represented in Figure 4.

The sun shade screen can moreover be provided on its superior contour 5" with a little collar 6 and extending towards the exterior of the screen 5 and lying for example in the plane defining the superior contour 5""of the sun shade screen 5 and situated on the exterior of this contour 5'. The little collar 6 essentially comprises a reflective surface 55 on the side exposed to the Sun So and a surface dissipating the heat 56 on the opposing side.

The invention comprises moreover means of maintaining the crown 4 on the north face N (or south S) of the satellite St while still permitting its rotation, just as means of assuring this rotation. These means are indicated by the reference markers 7 and 67 respectively in Figure 2; they are described in more detail below. Figure 3 represents in section the sun shade screen 5 which is composed of two parts: a polished thin sheet of aluminium 35 that assures the rigidity of the screen 5 and a layer 36 assuring the thermal isolation and whose face that is exposed to the Sun is chosen in a reflective material. The sun shade screen 5 is connected to the crown 4, which is also seen in section, by means of an ensemble composed of titanium bolts 37 and washers 38 located between the crown 4 and the screen 5, just as between the heads of the bolts 37 and the screen 5, and whose principal function is to assure a thermal isolation.

The ring 4 is toothed in 17 on its exterior circumference and provided moreover with two oblique roller tracks 15 and 16 upon which roll respectively, at three locations spaced angularly at 120°, two rollers 9 and 10. The axis of each of these rollers 9 and 10 is held in the branches of a fork 18 capable of sliding in the cases 21 serving as housings for the springs 20 that press the forks 18 towards the interior of the crown 4 in supporting themselves on the washers 19 fixed to the forks 18. The housings 21 are fixed to the structures 22 themselves fixed to a stirrup 23 of the satellite St by means of other titanium bolts 25 and washers 24.

This device therefore permits exertion of a force on the crown 4 of which the radial component is oriented towards the interior and of which the vertical components are in opposing directions and of equal modulus for the two rollers 9 and 10. There results, therefore, a perfect equilibrium for the three ensembles 7.

It remains now to describe the manner in which the rotation of the crown is effected. It is clear that this rotation must be continuous or at least executed at sufficiently close intervals and with small steps to take account of the continuous variation of the orientation of the Sun So; furthermore, the regulation of the speed of rotation must be perfect, in a manner to guarantee a good orientation of the sun shade screen 5 throughout the duration of the life of the geostationary satellite.

A stepper motor 59 provided with a gear 8 drives the crown 4 directly. The command signals for this motor are driven by the clock on board the satellite of which the stability, even throughout a lifetime of 10 years, guarantees sufficient precision.

It can be seen that this sun shade system of lightweight(?) construction is quite simple; the mechanical efforts brought into play are slight and therefore permit light dimensioning of the material object of the invention.

One finds oneself therefore in the presence of an attractive system for increasing the efficiency of removal of heat dissipated by infrared sensors of geostationary satellites, which is capable of greatly improving the precision of their measurements.

Claims

1. Sunshade device for geostationary satellite, comprising a crown (4) disposed around a zone (3) to be protected from solar radiation, means (7) of positioning the crown allowing the latter to rotate around the satellite axis (St) orthogonal with the plane of the earth's equator (Eq), rotation means (67) for this crown (4), and a screen reflecting (5) the solar radiation fixed on

the crown (4) and extending over an angular sector of the latter, characterised in that the zone to be protected has a polar orientation and in that the screen widens out in proceeding away from the crown (4) and has a variable height along its circumference.

2. Sunshade device for geostationary satellite according to claim 1, characterised in that the screen (5) is substantially in the form of a cylinder wall that is oblique in relation to the polar orientation or of a section of a cone having the crown (4) as its base, and has moreover an upper contour (5') delimited by a plane intersecting the plane of the crown, giving it a greater height at the centre than at its extremities.

3. Sunshade device for geostationary satellite according to claim 2, characterised in that the upper contour (5') of the screen (5) is provided with a collar (6) situated substantially in the plane delimiting said contour and situated outside of this contour.

4. Sunshade device for geostationary satellite according to any of claims 1 to 3, characterised in that the screen (5) reflecting the solar light comprises a polished aluminium plate (35) and, outside the latter, a layer of material (36) ensuring the thermal isolation and the reflection of the solar radiation.

5. Sunshade device for geostationary satellite according to claim 1, characterised in that the positioning means (7) comprise, in three zones regularly distributed over the crown (4), two rollers (9, 10) with axes intersecting the axis of rotation of the crown (4);
    - pressed on different bearing surfaces (15, 16) of the crown (4) using spring devices (18 to 22),
    - exerting on the crown (4) radial forces in the same directions and vertical forces in opposite directions.

6. Sunshade device for geostationary satellite according to claim 1, characterised in that the crown (4) comprises a toothed circumference (17) and in that the means of rotating the crown (4) comprise a stepper motor (59) terminated with a toothed wheel (8) which engages with the crown (4).

7. Sunshade device for geostationary satellite according to claim 3, characterised in that the collar (6) comprises a reflecting coating (55) on the side exposed to the Sun (So) and a heat dissipating coating (56) on the opposite side.

8. Sunshade device for geostationary satellite according to any of claims 1 to 7, characterised in that the angular sector over which the screen (5) extends is close to 180°.

9. Sunshade device for geostationary satellite according to any of claims 2 to 8, characterised in that the height of the screen (5) is very nearly zero at the extremities.